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Ash Fuel Reburn and Beneficiation

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Ash Fuel Reburn and Beneficiation at We Energies

Introduction

We Energies developed two coal ash beneficiation processes that involve reburning high carbon ash with coal. The processes convert a high carbon ash into a more marketable and useable product while extracting the residual energy content. The ash fuel reburn processes offer several environmental and economic benefits and have been demonstrated at We Energies coal-fired power plants located in Wisconsin and Michigan's Upper Peninsula. This case study examines the reburn program at We Energies, its benefits and the barriers that were overcome to successfully implement these patented processes.

Ash Fuel Reburn Process

We Energies has a patented process (U.S. Patent # 5,992,336) that allows bottom ash and fly ash with high loss on ignition (LOI) to be reburned in a pulverized coal furnace. There are two mechanisms that are included in this patented process – dry and wet reburn systems. In the dry reburn system fly ash is introduced into the boiler with the pulverized coal stream and fed to the burners through an injection port after the classifiers. This also can be accomplished by injection into the pulverized coal stream before the classifiers; or the secondary air stream entering the furnace adjacent to the coal diffusers of each burner; or through independent injection ports located above or adjacent to the coal stream burners. The wet reburn system adds relatively coarse bottom ash (or mixtures of bottom ash and wet fly ash) to the coal upstream of the pulverizers. The ash can be fed to the unit in the range of less than 1 to 3.5%, by weight, of the pulverized coal. The coal combustion products (CCP) to be reburned is analyzed routinely for sulfur, moisture, trace metal and energy content for air emissions and energy analyses.

We Energies found that it is advantageous to reburn high carbon coal ash from a boiler with less efficient combustion by transporting it to another boiler where more complete combustion occurs. An increasing number of utility boilers produce a high LOI ash due to the modified operating conditions required to reduce air emissions of nitrogen oxides (NOx). The high LOI ash (exceeding 20% LOI) entering the reburn systems is burned to produce a high quality ash with an LOI of less than 1%. The fuel value of the high LOI ash varies with the carbon and moisture content. Generally the fuel value of the ash used at the reburn system, on a dry basis, is between 2,000 and 5,000 Btu/lb.

In addition to high carbon ash being produced by power plants, there are significant volumes of high carbon ash deposited in existing landfills, particularly in regions where electricity was, or is, generated by burning bituminous coal. We Energies developed a patented process that involves identifying the appropriate previously used disposal site, recovering at least a portion of the CCP, determining LOI and, if cost effective, introducing the CCP to a pulverized coal furnace for reburning in the same manner as the wet reburn system described earlier. In 2003 We Energies was issued a patent for this process (U.S. Patent # 6,637,354).

Both the wet and dry reburn processes convert high LOI ash that has limited uses and markets into a low LOI CCP that can be used in construction materials. Prior to We Energies ash fuel reburn program, most of the high LOI ash was landfilled. Now, the reburned ash is fused and combined with the ash from the combustion of subbituminous or bituminous coal. The Class C or F fly ash can be sold as a supplementary cementious material for use in concrete and soil stabilization, and is a lime replacement for waste stabilization. The bottom

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ash is used as a structural, granular base material for constructing roads, parking lots and building pads.

We Energies' Pleasant Prairie Power Plant (P4) in Kenosha County, Wisconsin, reburns ash from two Milwaukee area plants: Valley Power Plant (VAPP) and Milwaukee County Power Plant (MCPP). On occasion P4 also reburns recovered coal ash from remediation projects in southeastern Wisconsin. Ash fuel is fed at approximately 2% by weight of the subbituminous coal. Since initiating the reburn program at P4, the plant reburned more than 308,000 tons of ash, producing over 138,000 tons of fly ash and avoiding up to 158,000 tons of CO_2 emissions by selling the fly ash to replace cement and lime. This also means that over 132,000 tons of coal (about 1,150 rail cars) were displaced. Of the total ash reburned, over 17,000 tons were recovered ash from We Energies' landfills.

P4 Reburn	Ash Reburned (tons)	Fly Ash Produced (tons)	Potential CO_2 Avoided (tons)	Avoided Coal Use (tons)	Avoided Coal Use (railcars)
2003 Projected	108,000	50,000	54,000	46,000	400
Total Since 2000	308,000	138,000	158,000	132,000	1,150

We Energies' Presque Isle Power Plant (PIPP) near Marquette, Michigan, has a wet reburn process that is used to burn bituminous coal bottom ash from the plant's older boilers in newer, more efficient boilers. Since the start of reburn at PIPP in July 2002, over 12,200 tons of ash were reburned to displace 2,800 tons of subbituminous coal (24 rail cars), creating 5,000 tons of fly ash and avoiding up to 5,700 tons of CO_2 emissions from the sale of fly ash to replace cement in concrete. The ash feed rate at PIPP is approximately 1% by weight of the coal.

PIPP Reburn	Ash Reburned (tons)	Fly Ash Produced (tons)	Potential CO_2 Avoided (tons)	Avoided Coal Use (tons)	Avoided Coal Use (railcars)
2003 Projected	6,400	2,500	2,700	1,600	14
Total Since 2002	12,200	5,000	5,700	2,800	24

Benefits

There are several environmental and economic benefits to using the ash fuel reburn process. Environmental benefits include preserving existing landfill capacity, reducing the need for new landfills and conserving natural resources. Since most of the fly ash produced by the reburn systems is used to replace cement in concrete, the program offsets carbon dioxide (CO_2), nitrogen oxides (NO_x), hydrogen chloride (HCl), and sulfur oxides (SO_x) emissions from cement kilns. It also avoids quarrying limestone and clay for portland cement production. Fly ash improves the durability, strength, and workability of concrete.

Economic advantages of the reburn process include avoided coal purchases, landfill expenses, and additional revenue from producing and selling concrete quality fly ash. Additional benefits include the ability to recover energy that would otherwise be lost and to

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conserve raw fuel for future generations. When ash recovered from landfills is reburned, former landfills can be redeveloped, and in the case of remediation projects, it offers an economical and effective alternative to conventional approaches.

Barriers to Implementation

We Energies overcame several obstacles to implementing the reburn process and addressed challenges that included regulatory barriers, market acceptance and perception issues.

In order to meet regulatory requirements for the air permits and be able to reburn ash at P4, We Energies demonstrated that the ash met the definition of coal by ASTM method D388-92. Although this ash met the definition of coal, the Wisconsin Department of Natural Resources (WDNR) requested that the permit exemption classify it as an alternate fuel. This request was made on behalf of the WDNR's Waste Management Section concerning the reclassification of fly ash or bottom ash as coal. We Energies accommodated this request since P4's existing air permit allowed the facility to use alternate fuel. We Energies conducted a test burn demonstrating that reburning the ash and handling the resulting CCP would be in compliance with all current operating permit limitations and that the unit was capable of accommodating this alternate fuel. On August 19, 1999 the WDNR approved the commercial operation of the ash fuel reburn system with yearly limits on the amount of ash that could be reburned.

Removal of CCP from landfills for either energy recovery or beneficial reuse was facilitated by a regulatory innovation program sponsored by WDNR and endorsed by the U.S. Environmental Protection Agency. The Environmental Cooperative Agreement pilot program was authorized by the Wisconsin legislature to encourage the testing of innovative approaches to managing environmental issues. The agreement between Wisconsin Electric Power Company doing business as We Energies and the WDNR signed on February 5, 2001 was the first of its kind in Wisconsin. (http://www.we-energies.com/environment/p4eca.htm) As part of this comprehensive, voluntary innovation agreement that covered air, water and land, We Energies was provided regulatory flexibility to change how it monitored and recorded its environmental performance at P4, its largest coal-fueled power plant in Wisconsin. In response to commitments to implement a formal ISO 14001 environmental management system (EMS) and periodically assess and publicly report on its performance, the company was allowed to optimize its environmental activities, including the testing and adoption of new environmental technologies. The most unique aspect of this flexibility was allowing We Energies to recover CCP from its landfills, thus reversing the usual process of landfilling what had been deemed waste ash. Under the agreement with the WDNR, We Energies was allowed to demonstrate the operational and environmental feasibility of opening a landfill cell and removing deposited materials. Approval of a generic material characterization and removal plan under P4's Environmental Cooperative Agreement provided the necessary assurance that materials could be removed without significant environmental risks. Approval was received from the WDNR to remove materials from nine of the company's existing and formerly used landfills.

Beneficial use of CCP, including materials recovered from the landfills, also was facilitated by Wisconsin's beneficial use rules (Chapter NR538 of the Wisconsin environmental regulations (http://www.legis.state.wi.us/rsb/code/nr/nr538.pdf) that had been developed during the 1990's. These rules seek to promote pollution prevention and waste minimization by encouraging a broad range of beneficial uses of industrial byproducts while assuring that

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all appropriate environmental precautions are taken. Use as an alternate fuel is included among the approved beneficial uses. Annual reports are submitted to the WDNR outlining the volumes and characteristics of beneficially used materials. A broader environmental performance report is published annually covering all aspects of the regulatory innovation agreement between We Energies and the WDNR. http://www.wec-performancereport.com

The ultimate success of the program required addressing several challenges related to the ash uses and market. We Energies is fortunate to have longstanding relationships with innovative ash marketers. The ash marketing contracts were negotiated to allow ash fuel reburn but required that high quality standards must still be met. Early test burns indicated no substantial change to the LOI of the ash, but long-term testing would not necessarily have the same results. Customers using P4 or PIPP fly ash have expectations for a consistent, high quality product; therefore, it was important not to jeopardize the reputation of the fly ash. We Energies carefully and slowly increased the reburn feed rate and monitored the ash closely as these changes were made. Putting limits on the percent addition (by weight) of ash to the coal was critical to maintaining consistently low LOI. Quality data collected to date show no negative impact of reburn on the fly ash quality. There are indications that there are positive impacts of the reburn systems fly ash performance in concrete, but more conclusive studies are needed to substantiate the improvements such as better mitigation of alkali silica reactions in concrete. (See Malisch, Ward R. 1998. Blending fly ash for a better concrete. *The Concrete Producer*, June.)

In addition, the reburn system is set-up to allow segregation of off-spec material in the event that the quality deviates from the standards.

We Energies experienced some internal challenges in convincing employees that ash fuel reburn was the right thing to do. Training on the benefits of the reburn system helped to educate employees about the necessity for additional work and required changes. For example, senior management approved approximately $3,000,000 to construct the dry ash fuel reburn system at P4. Annual operation and maintenance expenses of the reburn system caused the expenditures for the reburning plant to increase, but overall there are significant system-wide savings for the company. The economic benefits for the program depend on system throughput, but for We Energies in 2003, the dry system provided approximately $2,000,000 in annual net benefits to the company and its electrical customers. The wet reburn system at P4 is currently being modified to increase its throughput capacity. Net benefits are substantial for the wet system but difficult to assess at this time.

Conclusion

The ash fuel reburn process offers practical and economical means to make a more marketable CCP from high carbon ash from existing power plants and landfills. By developing a working relationship with the regulatory agencies and taking a practical approach to creating solutions to obstacles, We Energies has been able to successfully operate the ash fuel reburn systems and develop a new ash utilization program that benefits the company, its customers and the environment.

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